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REFRIGERATING APPARATUS

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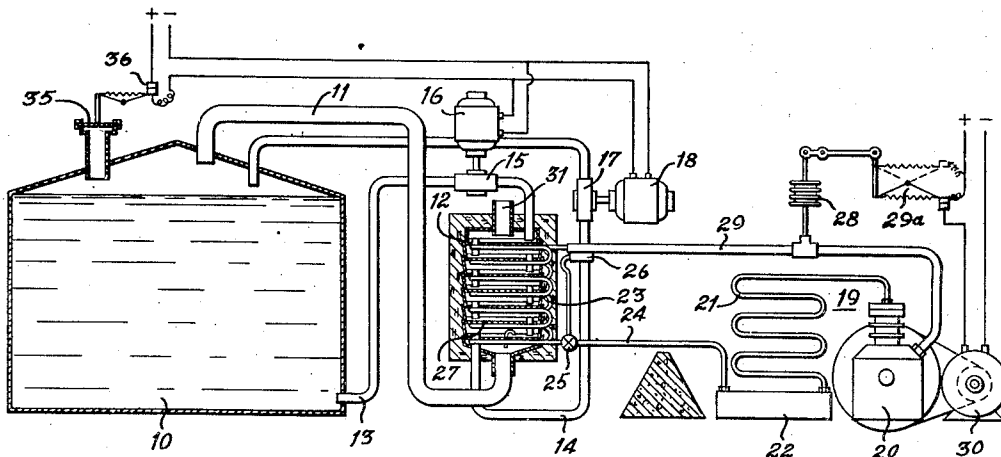


Fig. 1

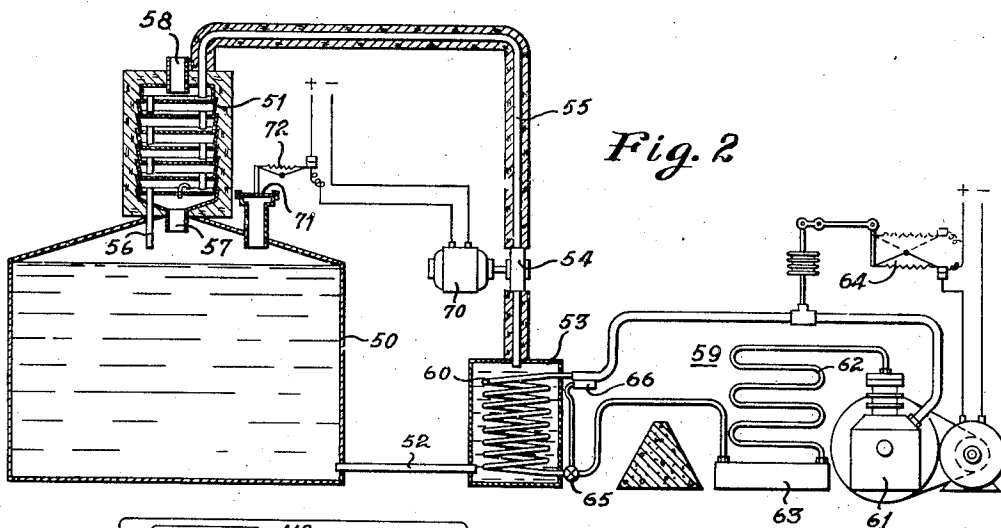


Fig. 2

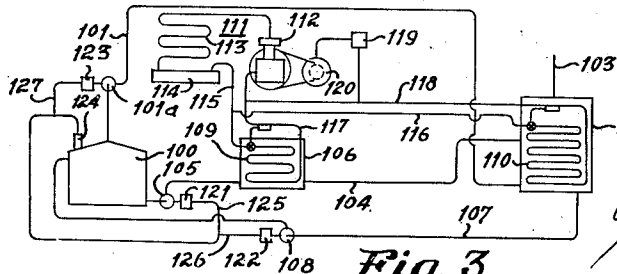


Fig. 3

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REFRIGERATING APPARATUS

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16 Claims. (Cl. 62—122)

This invention relates to refrigeration, and more particularly to the recovery of vapors from storage tanks and the like.

It is among the objects of this invention to provide an improved method and apparatus for recovering vapors, such as hydrocarbon vapors, from storage tanks or the like containing hydrocarbon or other volatile liquids and thus to prevent loss of such vapors by reason of the breathing action inherent in such tanks.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred form of the present invention is clearly shown.

In the drawing:

Fig. 1 is a diagrammatic representation of one embodiment of this invention;

Fig. 2 is a diagrammatic representation of another embodiment of this invention;

Fig. 3 is a diagrammatic representation of still another embodiment of this invention.

According to my invention, vapors from storage tanks 10 are conveyed by a vapor conveying means or pipe 11 to a contact means 12. Here the vapors are contacted with a liquid preferably conveyed from the tank by liquid conveying means or pipe 13. The vapors are absorbed here by the liquid in the contact means and, preferably, the liquid with the absorbed vapors is returned to the storage tank 10 by liquid conveying means 14 connecting the contact means 12 and the tank 10.

Suitable circulating devices are provided for insuring the circulation of the various fluids. Ordinarily the vapors from the tank 10 circulate due to pressure differentials created between the tank and the atmosphere by reason of temperature or barometric changes or because of filling operations, and hence no positive circulating means need be provided for the hydrocarbon vapors, as indicated in Fig. 1; but it is within the purview of this invention to provide a blower or blowers in any of the modifications, in the manner indicated in Fig. 3. Circulating means are provided for circulating hydrocarbon liquid through the pipe 13 including a pump 15 driven by an electric motor 16. Circulating means are provided for the hydrocarbon liquid in the pipe 14 including a pump 17 driven by a motor 18.

Refrigerating apparatus is provided to cause absorption of vapors by the liquid. In the form shown in Fig. 1, refrigeration is applied to the contact means 12. Preferably this refrigeration is applied by means of an artificial refrigeration

system. Such a system may comprise a refrigerant liquefying unit 19, for example, in the form of a compressor 20, condenser 21, liquid refrigerant receiver 22, and this unit is connected to a refrigerant evaporator 23 in refrigerant circulating relationship. Liquid refrigerant pipe 24 connects the receiver 22 and the evaporator 23 and is provided with a refrigerant expansion device or valve 25. This valve may be of any suitable type, for example, a thermostatically operated valve made responsive to temperatures in the thermostatic bulb 26 placed at or near the outlet of the evaporator 23 in the well known manner. The evaporator 23 may be in the form of a series of pipe bends or loops in thermal contact with contact pans or baffles 27.

Means are provided for automatically maintaining the temperature of the applied refrigeration between predetermined temperature limits. One way of accomplishing this includes a bellows 28 connected to the refrigerant vapor line 29 which is interposed between the evaporator 23 and the compressor 20. The bellows 28 operates a snap switch 29a which starts and stops motor 30 which drives the compressor 20. The bellows 28 and snap switch 29a are so calibrated that they maintain the refrigerant temperature in evaporator 23 within predetermined limits.

If desired, the operation of the motors 16 and 18 may be made dependent on pressures within the tank 10. Thus a diaphragm 35 is provided which is responsive to pressure differential between the tank 10 and the atmosphere. This diaphragm 35 operates a snap switch 36 which in turn controls operation of the motors 16 and 18. Preferably the diaphragm 35 is so calibrated that when the vapor pressure in the tank 10 is greater than the atmospheric pressure, then the motors operate to convey liquid to and from the contact means 12, but when the vapor pressure in the tank 10 is equal to or less than the atmosphere then the motors do not operate. While the preferred form of the invention includes automatic operation of these motors, it is within the purview of the invention to control their operation otherwise, such as by manually controlled switches.

In the operation of the embodiment shown in Fig. 1, the vapors, forced from the tank 10 by breathing action, flow through the pipe 11 to the contact means 12. Any unabsorbed gaseous residue is discharged through the pipe 31 into the atmosphere or any other desired place. Absorbing liquid, in this embodiment hydrocarbon liquid from the tank 10 itself, is circulated by the pump 15 to the contact means 12 where it is discharged

on the upper contact pan and trickles to the bottom of the contact means 12, from whence it is returned, with the absorbed vapors, through the pipe 14 and pump 17 to the tank 10. In passing through the contact means 12, the hydrocarbon liquid absorbs the hydrocarbon vapors because of the low temperature maintained by the refrigerating apparatus.

In the modification shown in Fig. 2, a storage tank 50 is provided with a contact means 51 conveniently placed on top of the tank, although it is within the purview of this invention that the contact apparatus may be placed at any other suitable location. Hydrocarbon liquid is circulated from the tank 50 by a liquid conveying means, including the pipe 52, cooler 53 to pump 54 and pipe 55, to the contact means and is returned to the tank from the contact means by a liquid conveying means or pipe 56. The vapors from the tank 50 are conveyed to the contact means by a vapor conveying means or pipe 57 and any unabsorbable gaseous residue is discharged through the pipe 58 to the atmosphere.

Refrigeration to cause absorption of the vapors is applied, in this particular embodiment, to the hydrocarbon liquid as it is being conveyed to the contact means 51. Thus an evaporator 60 of the refrigerating apparatus or system 59 is thermally connected to the cooler 53. The refrigerating apparatus also includes a compressor 61, condenser 62, receiver 63, automatic control 64, thermostatic expansion valve 65 and thermostatic bulb 66 operates substantially in the same manner as the corresponding parts in Fig. 1.

The pump 54 is operated by a motor 70, and in this embodiment the motor may be also operated in accordance with vapor pressures in the tank 50. Thus a diaphragm 71 operates a snap switch 72 in a manner similar to the operation of the diaphragm 35 and switch 36 in Fig. 1 and causes the motor 70 to operate whenever the vapor pressure in the tank 50 is greater than atmospheric pressure and causes the motor to stop when the vapor pressure in the tank is equal to or less than atmospheric pressure.

In the embodiment shown in Fig. 3 the tank 100 is connected by vapor conveying means or pipe 101 and blower 101a with contact means 102. Any unabsorbed vapors or gases may be discharged through the pipe 103 into the atmosphere or other suitable space. Hydrocarbon liquid may be conveyed from the tank 100 by the liquid conveying means or pipe 104 through the pump 105, and cooler 106 to the contact means 102. The liquid, with the absorbed vapors, may be returned to the tank 100 through the liquid conveying means or pipe 107, including the pump 108.

Refrigeration may be applied to cause the liquid to absorb vapors. Thus a refrigerating apparatus or system may be connected with evaporator 109 in the cooler 106 and evaporator 110 in the contact means 102. The evaporators 109 and 110 may be connected in parallel flow relationship with the refrigerant circulating means 111 which may be a refrigerant liquefier of the type disclosed in Figs. 1 and 2.

The refrigerating liquefier thus may include a compressor 112, condenser 113, and receiver 114. Liquid refrigerant lines 115 and 116 connect the receiver 114 with the evaporators 109 and 110 respectively, while vapor lines 117 and 118 connect these evaporators with the intake of the compressor. An automatic pressure responsive snap switch 119 controls the motor 120 in accordance with the temperature-pressure char-

acteristics of the refrigerant in evaporators 109 and 110 and automatically maintains the temperature of applied refrigeration between desired limits.

Motors 121, 122 and 123 drive the pumps 105 and 108 and blower 101a respectively. These motors may be manually controlled, or if desired, may be automatically controlled in accordance with vapor pressures in the tank 100 by means of the pressure responsive switch 124, similar in construction and operation to diaphragm 35 and switch 36 in Fig. 1. The switch 124 is electrically connected to the motors 121, 122 and 123 respectively by lines 125, 126 and 127 which form part of the electrical circuits for these motors as readily apparent.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. The method of recovering hydrocarbon vapors from a storage tank or the like which comprises conveying said vapors from said tank to a contact means, conveying hydrocarbon liquid to said contact means from said tank, and applying refrigeration to cause absorption of said vapors by said liquid.

2. The method of recovering hydrocarbon vapors from a storage tank or the like which comprises conveying said vapors to and from said tank to and from a contact means by a breathing action, conveying hydrocarbon liquid to said contact means, and applying refrigeration to said liquid to cause absorption of said vapors by said liquid.

3. The method of recovering hydrocarbon vapors from a storage tank or the like which comprises conveying said vapors from said tank to a contact means, conveying hydrocarbon liquid to said contact means, and applying refrigeration to said contact means to cause absorption of said vapors by said liquid.

4. The method of recovering hydrocarbon vapors from a storage tank or the like which comprises conveying said vapors from said tank to a contact means, conveying hydrocarbon liquid to said contact means, and applying refrigeration to said liquid and contact means to cause absorption of said vapors by said liquid.

5. The method of recovering hydrocarbon vapors from a storage tank or the like which comprises conveying said vapors from said tank to a contact means, conveying hydrocarbon liquid to said contact means from said tank, and applying refrigeration to said liquid to cause absorption of said vapors by said liquid.

6. The method of recovering hydrocarbon vapors from a storage tank or the like which comprises conveying said vapors from said tank to a contact means, conveying hydrocarbon liquid to said contact means from said tank, and applying refrigeration to said contact means to cause absorption of said vapors by said liquid.

7. The method of recovering hydrocarbon vapors from a storage tank or the like which comprises conveying said vapors from said tank to a contact means, conveying hydrocarbon liquid to said contact means from said tank, and applying refrigeration to said liquid and contact means to cause absorption of said vapors by said liquid.

8. The method of recovering hydrocarbon vapors from a storage tank or the like which com-

prises conveying gases to and from said tank by a breathing action and thereby conveying hydrocarbon vapors from the liquid in said tank, contacting said vapors with a vapor converting means, applying refrigeration to said means and automatically maintaining the temperature of the said refrigeration between predetermined temperature limits.

9. The method of recovering hydrocarbon vapors from a storage tank or the like which comprises conveying gases to and from said tank by a breathing action and thereby conveying hydrocarbon vapors from the liquid in said tank, conveying said vapors to a contact means, conveying hydrocarbon liquid to said contact means, applying refrigeration to cause absorption of said vapors by said liquid, and automatically maintaining said refrigeration between predetermined temperature limits.

10. The method of recovering hydrocarbon vapors from a storage tank or the like which comprises conveying said vapors from said tank to a contact means, conveying hydrocarbon liquid to said contact means from said tank, applying refrigeration to cause absorption of said vapors by said liquid, and automatically maintaining said refrigeration between predetermined temperature limits.

11. The method of recovering hydrocarbon vapors from a storage tank or the like which comprises conveying said vapors from said tank to a contact means, conveying hydrocarbon liquid to said contact means from said tank, applying refrigeration to cause absorption of said vapors by said liquid and returning said liquid to said tank.

12. An apparatus comprising a storage tank, vapor conveying means from said tank, contact means connected to said vapor conveying means, liquid conveying means for conveying liquid from

said tank connected to said contact means and refrigeration apparatus connected to one of said means.

13. An apparatus comprising a storage tank, vapor conveying means from said tank, contact means connected to said vapor conveying means, liquid conveying means for conveying liquid from said tank connected to said contact means, refrigeration apparatus connected to one of said means, and means for conveying liquid from said contact means to said tank.

14. An apparatus comprising a storage tank, vapor conveying means from said tank, contact means connected to said vapor conveying means, liquid conveying means for conveying liquid from said tank connected to said contact means, refrigeration apparatus connected to one of said means, and means for controlling said refrigeration apparatus to maintain a refrigerating temperature within predetermined limits.

15. The method of recovering hydrocarbon vapors from a storage tank or the like which comprises conveying gases to and from said tank by a breathing action and thereby conveying hydrocarbon vapors from the liquid in said tank, conveying said vapors through a vapor converting means, applying refrigeration to said means and automatically controlling the refrigeration in accordance with conditions in said tank tending to create a breathing action.

16. The method of recovering hydrocarbon vapors from a storage tank or the like which comprises conveying gases to and from said tank by a breathing action and thereby conveying hydrocarbon vapors from the liquid in said tank; conveying said vapors through a vapor converting means, applying refrigeration to said means and automatically controlling the refrigeration in accordance with pressure conditions in said tank.

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